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Cyanocyclas brasiliana (Bivalvia: Cyrenidae) rediscovered in the limnic part of Parnaíba River delta, Northeast Brazil

Carla Suzy Freire de Brito[1, 3*], **Maria Cristina Dreher Mansur**[2] and **Cristina de Almeida Rocha-Barreira**[1]

1 Universidade Federal do Ceará, Instituto de Ciências do Mar, Laboratório de Zoobentos, Avenida Abolição 3207, Meireles, 60.165-080, Fortaleza, CE, Brazil
2 Universidade Federal do Rio Grande do Sul, Centro de Ecologia, Av. Bento Gonçalves 9500, 91.540-000, Porto Alegre, RS, Brazil
3 Universidade Federal do Piauí, Campus de Parnaíba, Curso de Engenharia de Pesca, Av. São Sebastião 2819, Reis Veloso, 64.202-020, Parnaíba, PI, Brazil

* Corresponding author. E-mail: carlasuzy@hotmail.com

Abstract: *Cyanocyclas brasiliana* (Deshayes, 1854) known only from the original very short description and reported from Pará state was recently rediscovered. This is the first occurrence of a native species of Cyrenidae (formerly Corbiculidae) in the Northeast Region of Brazil. Due to a lack of previous data *C. brasiliana* was initially confused with *Corbicula largillierti* (Philippi, 1844), an invasive species of Asian origin, which was introduced in South America in the 1970s and already recorded from the North and Northeast regions of Brazil. Ecological aspects are described. To aid identification, type material was studied.

Key words: native species, Cyrenidae, Piaui, Northeast Brazil, ecology

In South America there are four orders of Bivalvia with representatives in freshwater: Mytiloida, Unionoida, Veneroida and Myoida (Mansur 2008). Despite the large number of mollusc species already described worldwide, knowledge of Brazilian freshwater molluscs is far from being satisfactory. Simone (1999) estimated that only half of the freshwater gastropods in the country are known, and Avelar (1999) commented that approximately 35 species of freshwater bivalve molluscs in Brazil are undescribed. Certainly, the Amazon region is one of the areas most in need of surveys and a better understanding of its species, including their environmental adaptations and ecological issues (Pimpão 2007). Pereira et al. (2012) published a key for the identification of native and introduced bivalves in Brazil and reported on the lack of comparative morphological studies, catalogs and taxonomic revisions of both Unionoida and smaller bivalves, the native Cyrenidae (= Corbiculidae) and Sphaeriidae, which are very poorly represented in scientific collections. These authors also noted areas still needing inventorying, including the North, Northeast and Mid-West regions of Brazil, where the river basins have changed relatively little until now.

Studying the representatives of native Cyrenidae, Parodiz and Hennings (1965) revised the taxonomy of numerous species in the genus *Neocorbicula* Fischer, 1887, and reduced the number of 30 nominal species in the central and southern regions of South America to two: *N. limosa* (Maton, 1809) and *N. paranensis* (d'Orbigny, 1835). Currently *Neocorbicula* is a synonym of *Cyanocyclas* Blainville, 1818, according to Parodiz (1996).

The species described from the Amazon, *Cyanocyclas brasiliana* (Deshayes, 1854) and *C. amazonica* (Prime, 1870), as well as those from northern South America, *C. bavayi* (Ancey, 1880), *C. cuneata* (Jonas, 1844), *C. rotunda* (Prime, 1860), and *C. surinamica* (Clessin, 1879), need to be revised (Mansur 2008; Parodiz and Hennings 1965; Mansur et al. 2004).

In the original descriptions of both species, locality data are vague and imprecise. Deshayes (1854) described *C. brasiliana* from the state of Para in Brazil, without further data, and Prime (1870) described *C. amazonica* from the Amazon River, Brazil, in the stomach of a fish. Simone (2006) catalogued the native and invasive freshwater cyrenids of Brazil, and provided illustrations (external and internal view of both valves), as well as the length of a syntype of *C. amazonica* and a topotype of *C. brasiliana*. This figured topotype is from the Natural History Museum (London, UK; NHMUK) and correspond to the first illustration of the species. There are no previous records of continental native South American cyrenids from the Northeast Region of Brazil. However, cyrenids living in high densities were observed in the limnic portion of the Parnaiba River delta, Piauí

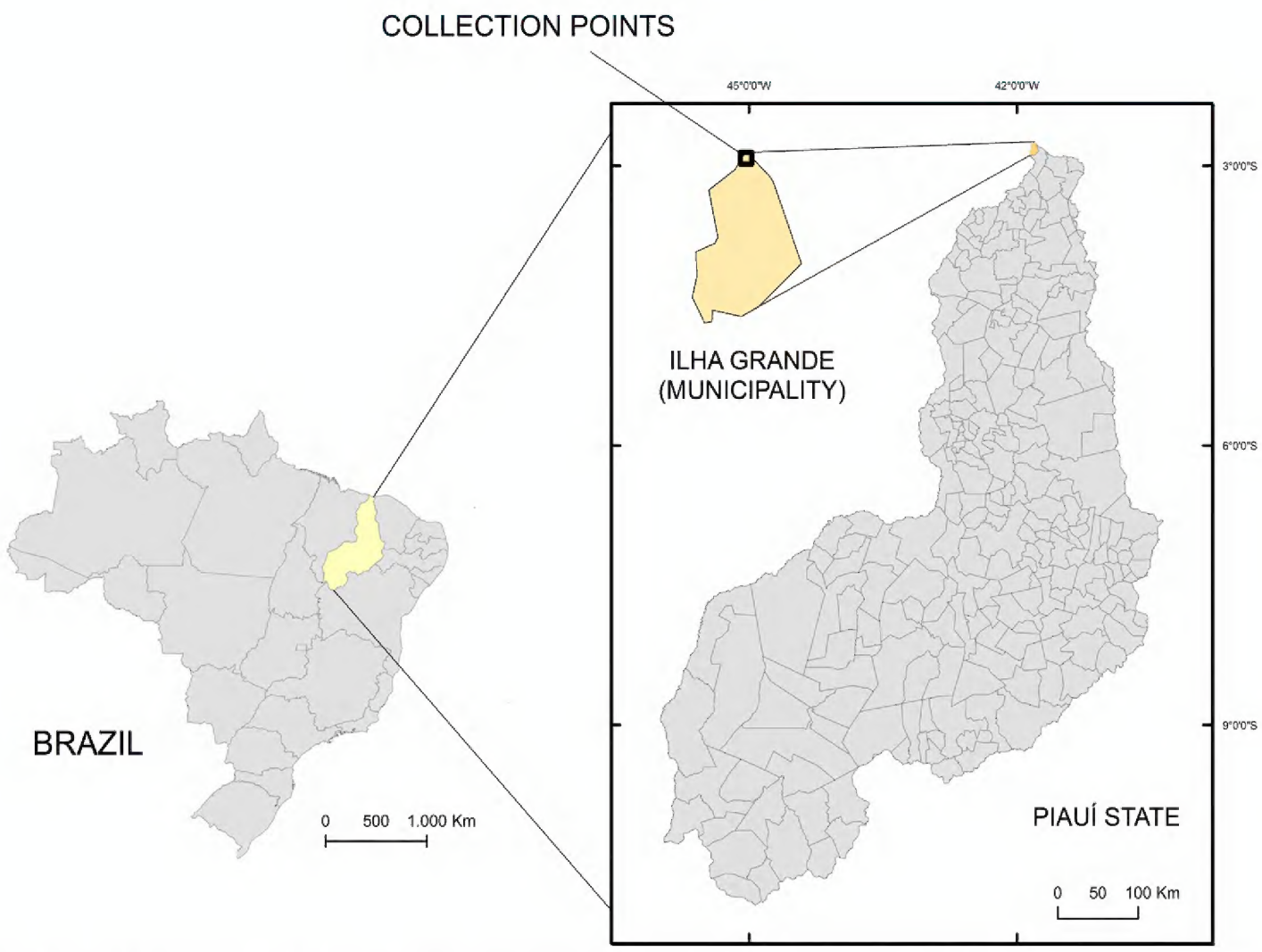

Figure 1. Map of Parnaíba River delta and Ilha Grande municipality near the sampling station, Piauí state, Brazil.

state. Although intensely harvested by local people for several generations, this bivalve population had not been identified until now.

This work records the rediscovery of *C. brasiliana* outside of the Amazonas basin and the first occurrence of a native species of the family Cyrenidae in the Northeast Region of Brazil. Due to the scarcity of data on *Cyanocyclas* from river basins of the northern and northeastern part of Brazil and South America and considering the absence of samples in Brazilian scientific collections, we contribute additional taxonomic, morphological and ecological data on *C. brasiliana*.

Samples were taken in the upper estuary of the Parnaíba River, located in the Area of Environmental Protection of the Parnaíba River delta, near Ilha Grande, 10 m above sea level, in the municipality of Parnaíba, Piauí state (02°49′ S, 041°50′ W) (Figure 1). The climatic conditions of the area present range of temperatures from 25–35°C (IBAMA 1998). The sampling sites are located on two small islands, in the area popularly known as Gambôa do Mangue, which is located in the southern part of the Parnaíba River delta and is formed by two of the several channels of the Parnaíba River (Figure 1). This area presents marine flats and dunes on the opposite bank with tidal influence (IBAMA 1998). Four sampling sites were selected for ease of access these flats, because they are known to have bivalve molluscs, and because they are used by "marisqueiras" (women that harvest and sell seafood); the sites are: Site 1: 02°04′08.0″ S, 041°50′17.1″ W; Site 2: 02°49′23.4″ S, 041°050′23.8″ W; Site 3: 02°48′49.1″ S, 041°50′12.7″ W and Site 4: 02°48′49.6″ S, 041°50′13.2″ W (Figure 2).

Bivalve molluscs were collected in 2010 during low tide. The samples were taken with the aid of small trowels dug by hand for withdrawal the substrate to a "landuá" (a local fishing implement used as a strainer or sieve) adapted with a mesh opening size of less than 1 mm (less than the meshes used in conventional "landuás"; Figure 3). Once captured, the animals were placed in plastic container with water from the site and transported to the Laboratory of Limnology of the Federal University of Piauí (UFPI) in Parnaíba. In the laboratory, the samples were identified, measured and photographed, and then preserved in 70% ethyl alcohol with glycerin added. Samples were deposited in two malacological collections: Prof. Henry Ramos Matthews of the Institute of Marine Sciences of the Federal University of Ceará (CMPHRM 4779A) and the Natural Science Museum of the Zoobotanical Foundation, Porto Alegre, Rio Grande do Sul state (MCNZ 40.516). During examination of the South American freshwater bivalves collection at the Natural History Museum of United Kingdom (NHMUK), in 1986, the second author of the present paper located the original material used by Deshayes to describe the species *C. brasiliana* and noted the catalog number. In contact with Jonathan Ablett the actual curator of the above named Molluscs Collection, he located the syntype series of *C. brasiliana,* and sent us photographs. He included scale permitting us to measure all the samples.

Seven specimens of *C. brasiliana* from Parnaíba River delta, sampled in 23 September 2010, at Site 3, were measured. The greatest length, maximum height, and maximum width were measured with a caliper

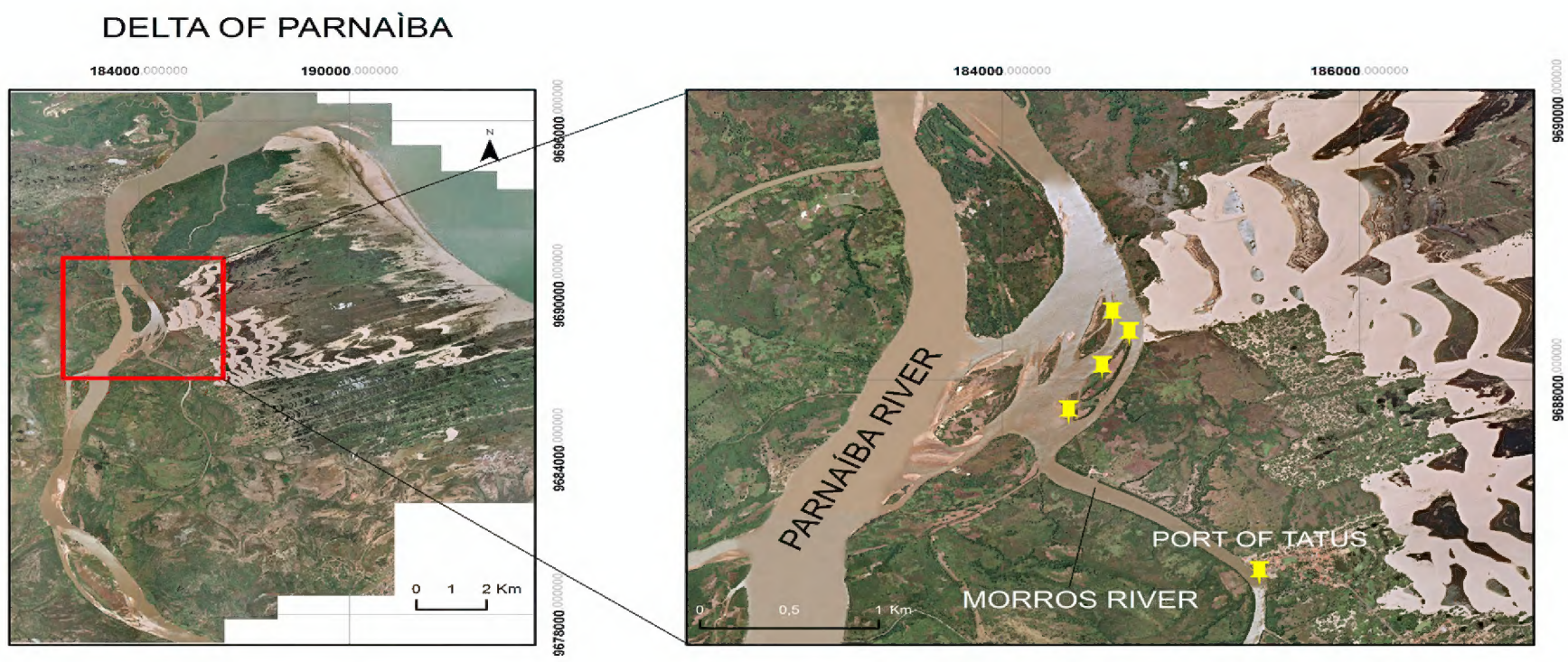

Figure 2. Aerial view of the sampling area (red square) located in two islands, on the margins of the channels of the Parnaíba River and satellite image with details of the four collecting points.

Figure 3. A: Material used for the collection of the samples (PVC quadrat, trowels and "landuá". **B** - "Landuá" adapted for sampling.

and compared to four syntypes (NHMUK 1845.8.29.7-10). The length/height ratios of the shells were also compared.

The original description by Deshayes (1854) of *C. brasiliana* is very short, not illustrated, and the author indicated that the material belonged to the collection of the British Museum by his use of the initials BM (now NHMUK). Prime (1865) subsequently redescribed *C. brasiliana*, briefly and in the same words as Deshayes and confirmed that the original material was in the collection of the British Museum. He admitted that he had not examined any specimens of the species. Later, he (Prime 1870) described a new species, *C. amazonica*, also briefly and without illustrations. Johnson (1959) listed the types of Prime collection, recorded the holotype of *C. amazonica* from the Museum of Comparative Zoology (MCZ; Harvard University), and provided a figure of the shell. Simone (2006) provided photos of both species, but the specimen shown in Figure 1036 and labeled as a topotype actually belongs to the syntype series of original material described by Deshayes (1854).

Simone (2006) offered photos of both species. Comparing with the illustrations of the type material sent by the curator Jonathan Ablett (NHMUK), we found out that the specimen showed on figure 1036, is not a topotype as mentioned by Simone (2006) but a syntype of the primary syntype series used by Deshayes in his description of *C. brasiliana*. In the original description, besides not providing illustration or measurements, there is no mention about the number of specimens examined (Deshayes 1854). The syntype series (NHMUK 1845.8.29.7-10) consists of a full-grown specimen about 19 mm long and three smaller specimens (Table 1).

Morphological comparisons reveal that the specimens (Figure 4) collected in the delta of the Parnaiba River belong to the genus *Cyanocyclas*, by the presence of a heterodont hinge with lamellar lateral teeth serrated on the top, and especially by a presence of a small and triangular pallial sinus (Figure 5: ps) in the pallial line just below the posterior adductor muscle. The presence of the pallial sinus is fundamental to distinguish the genus of *Cyanocyclas* from the invasive *Corbicula* Megerle von Mühlfeld, 1811. *Corbicula* species have the pallial entire, without a sinus (Santos et al. 2012; Pereira et al. 2012).

Table 1. Measurements of length, height and width and ratio of length/height of the shells of syntypes NHMUK (1845.8.29.7-10) and samples of *Cyanocyclas brasiliana* (Deshayes 1854) collected in Parnaíba River delta, Piauí, Brazil (MCNZ 40.516).

Samples	Length (mm)	Height (mm)	Width (mm)	Length/ height
NHMUK 1845.8.29.7-10 (Syntypes)				
A	19.0	17.5	10.8	1.2
B	10.7	10.0	6.8	1.1
C	12.0	10.7	7.5	1.1
D	11.6	11.2	8.0	1.0
Average	13.3	12.4	8.3	1.1
Standard deviation	3.3	3.0	1.5	0.1
MCNZ 40.516				
A (Figure 5)	23.8	22.1	15.0	1.1
C	27.2	23.2	15.3	1.2
B	26.2	23.2	14.0	1.1
D	25.9	23.0	14.9	1.1
E	26.0	22.8	14.1	1.1
F	25.6	22.5	14.2	1.1
G	24.7	21.7	14.6	1.1
Average	25.6	22.6	14.6	1.1
Standard deviation	1.0	0.5	0.5	0.0

The comparison of the type material of *C. brasiliana* with the samples from the Parnaíba River delta reveal that while a little larger, the latter present proportionally similar measurements of length, height, width, and length/height ratio (Table 1). Additionally some aspects of the shell are important to better define the species like (Figures 4 and 5): external surface glossy with narrow and conspicuous comarginal undulations (approximately three per mm), color varying from light brown and green straw, sometimes with shades or violet comarginal bands, umbos small and little inflated, hardly passing above the hinge line; beaks centrogyrous or slightly prosogyrous; internal surface opaque in the center and lustrous near the borders, color varying from white, pink to dark violet, hinge plate and lateral teeth relatively narrow, pallial sinus small resembling *C. limosa* but a little deeper than at *C. paranensis* and a very acute apex.

Figure 4. *Cyanocyclas brasiliana* (Deshayes 1854) collected in the limnic part of the delta of the Parnaíba River, Piauí state, Brazil.

In subsequent work it will be necessary to redescribe the species and also reveal details of the internal morphology. *Cyanocyclas amazonica* is probably a junior synonym of *C. brasiliana* considering that Prime (1870) confessed not having seen the material of *C. brasiliana* described earlier by Deshayes (1854). Moreover, both species come from the same river basin, and through the illustration by Johnson (1959) of the holotype and of a syntype of *C. amazonica*, provided by Simone (2006), it is possible to see strong resemblances. However, future taxonomic studies will require a more detailed examination and comparison of type materials of both species.

The distribution of *C. brasiliana* in the Parnaíba River delta is dependent primarily by salinity degree no higher than the 3 ppm. This species has little tolerance to small variations in salinity, thus corresponding to the oligohaline species. Even the smallest increase in salinity will cause high mortality. The influx of salty seawater into the delta is popularly known by local fishermen as "mare grande" (or "great tide"). Another factor that determines the presence and distribution of this species is the water depth and that depends on the tide and the type of substrate. Specimens are found at depths down to approximately 3 m in muddy substrate. It was observed that *C. brasiliana* in the Parnaíba River delta migrates according to the characteristics of the substrate. In places of muddy bottom the species was

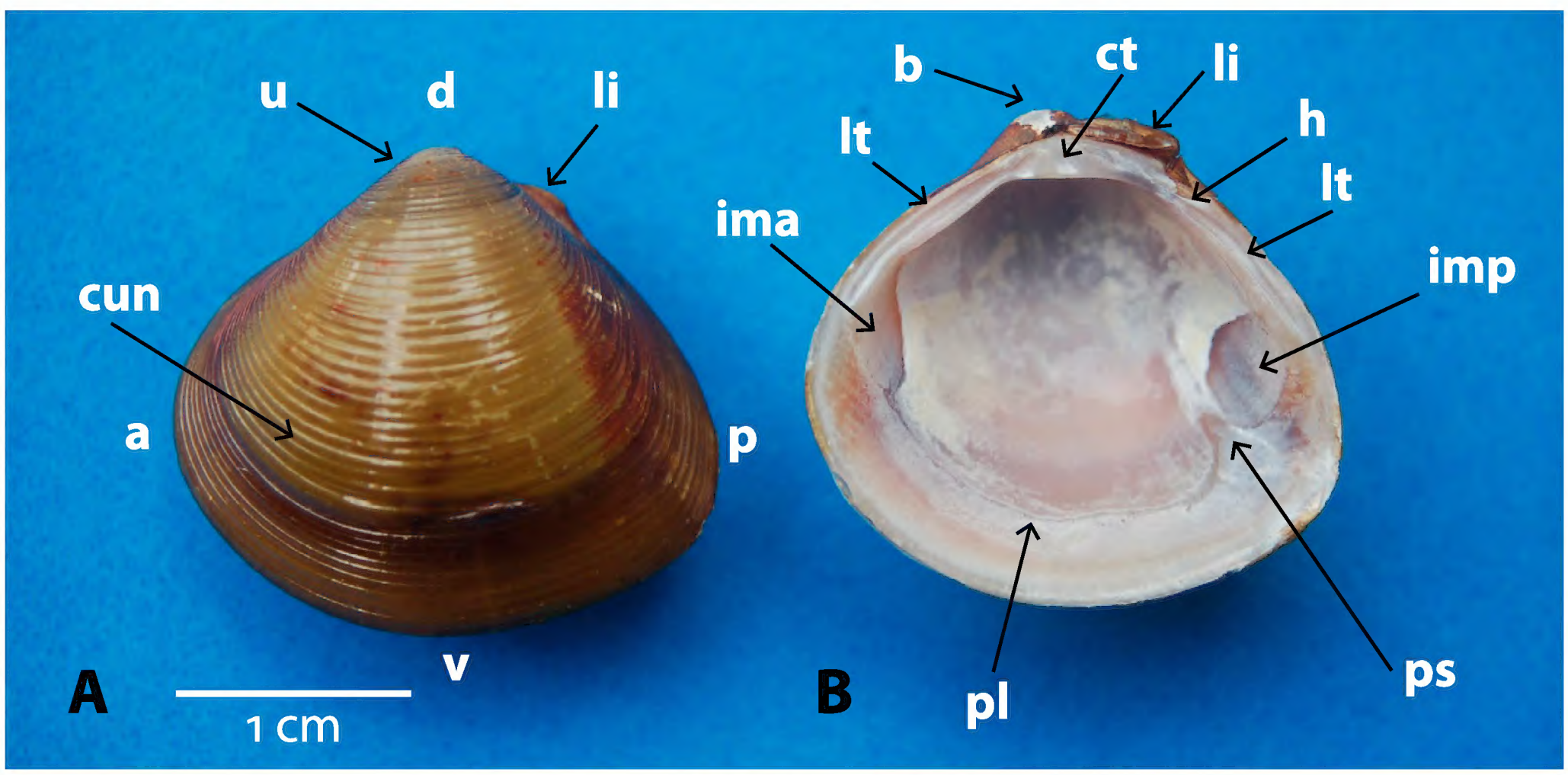

Figure 5. External (**A**) and internal view (**B**) of *Cyanocyclas brasiliana* (Deshayes, 1854) shell from the Parnaíba River delta, Piauí state, Brazil (MCNZ 40.516 A). Legend: a – anterior; b – beak; ct – cardinal teeth; d – dorsal; li – ligament; ima – impression of the anterior adductor muscle; lt – lateral teeth; h – hinge plate; imp – impression of the posterior adductor muscle; cun – commarginal undulations; p – posterior; pl – pallial line; ps – pallial sinus; u – umbo; v – ventral.

always present. However, when tidal flow changed the bottom to sand, *C. brasiliana* disappeared.

Shellfish caught commercially in this region are used by the local community. The harvest is done during low tide. Women harvest this species up to six hours per day throughout almost the entire year, except during September and October, the period of highest rainfall. According to the harvesters, around 500 kg of *C brasiliana* are gathered per day. It is estimated that approximately 6,000 kg are caught per month. The catch is almost exclusively sold to middlemen at extremely low prices; it is then exported to São Luis, Maranhão state, and São Paulo, São Paulo state. Just a few pounds are sold directly to the local community. Nothing is done with the shells except for paving roads, parking lots or backyards on local residences.

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